DEPTH, AND THE LARVAE AND PUPAE OF *STEGOMYIA FASCIATA*, F.

BY

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The larvae of *Stegomyia fasciata*, as is well known, are usually found in small collections of water in domestic utensils, old tins, rot-holes in trees, calabashes, rock pools, etc.; they are to a large extent bottom- and side-feeders, and are capable of remaining, and in fact frequently do remain, completely submerged for very considerable lengths of time. In many tropical countries where *S. fasciata* is prevalent, water is stored in tanks of some size and depth. Even if efficiently screened, larvae may gain access to these tanks by being washed in with rainwater as eggs or young larvae, and it is a matter of some interest to know if, supposing they were introduced in this way, the larvae of *S. fasciata* would be able to thrive or would be likely to escape by being drawn off with water from a tap situated near the bottom.

Iyengar (1920) observed at Calcutta that larvae of *S. fasciata*, which are found there in almost all domestic situations in which larvae of *Anopheles stephensi* are found, are, however, rarely encountered with them in wells. He accounts for this difference in habit by the fact that whereas the larvae of *A. stephensi* are provided with hooks at the ends of the dorsal hairs on the ninth abdominal segment by means of which they cling to the sides, the larvae of *S. fasciata* lack these hooks, and, therefore, he assumes, were they to frequent wells would have to go to the bottom if the water was disturbed. 'It is likely,' he thinks, 'that mosquito larvae, being air-breathing organisms, cannot ordinarily stand much pressure at the depth of a well. Stegomyia is a bottom- and side-feeder; therefore it has to go to the bottom of its breeding-place, unlike *A. stephensi*, which feeds on the surface. These facts explain why *Stegomyia* has rarely been found in waters which are over three feet deep.'

These statements set us wondering if it was, indeed, the case that larvae of *S. fasciata* could not withstand the pressure of more than about three feet of water, and if disturbed must inevitably go to the bottom. The following experiments were carried out to ascertain the facts.

The apparatus used consisted simply of a wide-mouthed bottle with sloping shoulders, connected by a stout piece of rubber tubing with a length of wide-bore glass tubing. The tube and the bottle were set up vertically, the one above the other, and securely clamped. When required, additional lengths of tubing were added at the top with short rubber connexions.

In such a system larvae of *S. fasciata* lived apparently at ease, and after a day or two congregated at the top, mostly in the first foot, a few in the second, and only stray individuals at greater depths. The successive stages observed in an actual experiment are shown in the Table. As will be seen, the larvae, which at first were

Day	1	2	3	4	5	6
1st foot	+	+	++	++ (Mostly at the top)	++ (Nearly all at the top)	++ (Nearly all at the top)
2nd foot	+	+	++	+−	5	1
3rd foot	+	+	+−	o	1	o
4th foot	+	+−−	1	o	o	o
5th foot	+	+−−	o	o	o	o
6th foot	+	+−−	o	o	o	o
7th foot	+	+	o	o	o	o

++ = many Larvae. + = several Larvae. +− = few Larvae.
+−− = very few Larvae. 1, 5, = one, five Larvae.

distributed throughout the tube, collected rather slowly at the top, so that after three days almost all of them were in the first foot of the column of water, and the majority at any particular moment actually at the surface. During this process of settling the habits of the larvae changed, bottom feeding being discontinued.

If then the tube was shaken or tapped, the larvae left the surface and wriggled down in the usual manner. They did not, however,

sink to the bottom; indeed, most of them descended only a few inches and very few more than one foot. Their descent was not passive, but was effected by active wriggling movements, and when these ceased they immediately began to float upwards towards the surface. Under ordinary circumstances, if disturbed the larvae wriggled downwards a few inches, ceased wriggling and floated upwards a short distance, and then recommenced active wriggling, this time towards the surface. They did not attempt to cling to the side of the tube. It is clear, therefore, that the larvae of *S. fasciata* when disturbed do not necessarily go to the bottom.

As the result of a single tap on the tube, it occasionally happened that one or two larvae descended to greater depths, such as two and a half feet or even three and a half feet. Larvae were also sometimes observed to descend voluntarily as much as five feet, and once one was found browsing on the side of the tube at a depth of 6 feet. By repeated tapping on the tube the larvae, could be urged to descend even deeper, eight feet at least. They did not appear to be at all incommoded by the pressure of the column of water, and when the tapping ceased wriggled back to the surface. Sometimes they rested on the bottom for a short time before starting the upward journey. It took one larva six minutes to regain the surface after descending seven feet.

In one experiment the system, consisting of the bottle and a long glass tube of wide bore of a total length of seven feet, was left standing until a copious growth of green algae had formed over the bottom, from which small bubbles of gas arose in sunlight and presumably kept the water oxygenated. In this system larvae of *S. fasciata* throve better than they did when no algae were present, and were more frequently seen at greater depths; indeed, both young and older larvae, but especially the former, were often seen browsing actually on the bottom. The pressure of the seven-foot column of water above them appeared to have no injurious effect whatsoever.

The pupae of *S. fasciata*, however, are not able to descend unharmed to such great depths as the larvae. As the result of a single tap on the tube, they usually descended only an inch or two and then floated passively back to the surface. By repeated tapping they could be induced to descend considerably further, but beyond

a certain depth (which in our experiments appeared to be about three feet to three and a half feet) they showed an unquestionable anxiety to return to the surface, ceasing to respond readily to disturbances, such as tapping or shaking, even when violently applied, descending further only very reluctantly, and sometimes refusing to move at all or actually ascending in spite of everything. In one experiment, by means of repeated tapping and shaking, a pupa was driven down to the bottom, a distance of seven feet. From this position it struggled upwards, evidently with increasing difficulty, for a distance of a little more than four feet. At about this level it managed to maintain itself for several minutes, now jerking itself up an inch or so, now sinking an inch or so, and then began to lose ground, at first slowly, then more quickly, and eventually sank to the bottom. Another pupa was similarly induced to descend five feet, but it managed to regain the surface. The inability of pupae to descend without ill-effects to such great depths as the larvae appeared to be dependent on their diminished buoyancy at such depths, which caused them to begin to sink the moment active movement was arrested. This fact should be correlated with the imperative need of pupae of access to air, for the strenuous efforts exerted in struggling upwards from an unaccustomed depth no doubt accelerated the exhaustion of the supply of air in their tracheal tubes.

REFERENCE

Iyengar, M. O. Tirunarayana (1920). Preliminary Report of a Malaria Survey of Calcutta and Environs. Special Indian Science Congress Number, 1920, of *The Indian Journal of Medical Research*, pp. 15-16.